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G. F. Hull

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An Investigation of the Influence of Electric Fields on Spectral Lines: Preliminary Note.

By Professor G. F. HULL, Dartmouth College, U.S.A.

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In general the electrical fields used were those concomitant with the luminous electric discharge. An interferometer of the Michelson form and an echelon spectroscope of 18 plates were used to analyse the radiations. The results may be summarised as follows:—

(1) End-on discharge tubes of special design, in which the light-source was a uniform column of luminous mercury vapour viewed in the direction of discharge, showed no change of wave-length as great as 1 part in 4,000,000 when the direction of the discharge was reversed. The pressure in the tube was varied from a few millimetres to a vacuum so high that there was but little luminosity.

(2) The passage of Röntgen rays through the tube did not alter the wave-length nor the width of the mercury lines, to an extent sufficient to affect the visibility of interference fringes formed with a difference of path of 400,000 waves. When the luminous column was viewed at right angles to the direction of the discharge no polarisation effects in the radiation from it, due to the passage of the Röntgen rays, could be detected by a sensitive Savart plate and Nicol prism.

(3) When the discharge passed in air between electrodes formed of an amalgam of cadmium and mercury, no variation of the wave-lengths of the strong Cd, Hg, lines greater than 0.002 tenth-metres was obtained, by changing the line of sight from a direction along the discharge to one at right angles to that direction. Approximately the same result held good when a small capacity was inserted in the circuit, but in this case the discrepancies in the readings were larger.

This result shows that the luminous particles do not acquire a velocity in the direction of the discharge greater than 150 metres per second. Hence the curving of the image of the discharge produced by a rotating mirror, as in the Feddersen experiment, and as recently studied by Schuster and Hemsalech for individual spectral lines, appears to be due not so much to motion of luminous particles as to the propagation along those particles of a condition of luminosity.

(4) Doppler effects in the canal rays, as announced by Stark during the course of the present investigations, were found for the strong hydrogen

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lines. In some cases they appeared also in mercury lines. The velocities represented by the displacements of the lines were of the order of 4×10^5 metres per second for the hydrogen particles and 2.5×10^4 metres per second for those of mercury. But it was found that, in general, the luminous mercury particles in the canal rays did not move, at any rate with a velocity greater than 100 metres per second. In these cases the canal rays appear to be due to non-luminous particles streaming through the mercury vapour and producing luminescence in the latter, probably by bombardment.

(5) A glass tube was sealed on to a canal-ray tube, at right angles to the direction of the rays. This tube was covered by a piece of optical glass as free as possible from strain. A very sensitive combination of Savart plate and Nicol prism was used to detect, if possible, any polarisation that might exist in the light from the rays in hydrogen. After eliminating reflections from the walls of the tube no polarisation could be recognised.

(6) The light produced by electrical discharge, in uniform tubes 3 or 4 cm. in diameter, was examined perpendicular to the direction of discharge, at various points between the electrodes and also behind the perforated cathode. It was found that the principal hydrogen lines were greatly broadened in those parts where the electric field is known to be of great intensity. For example, the luminous layer covering the cathode (the dark space being 0.5 to 4 cm.) gave hydrogen lines 0.4 Angström units in width, but the lines of the second hydrogen spectrum and certain air lines were not appreciably broadened. This broadening seems to be due mainly to motion of the particles rather than change of free periods, for it is found to the same extent behind the cathode in the canal rays. The broadening is so great that it is not possible with the instruments at the writer's disposal to determine the shift of these lines except to fix a superior limit of 0.1 A.U. to its possible magnitude. The amount is probably considerably less than this. On the other hand, the shift of the lines of the second spectrum of hydrogen is so small as to approach the limits of error, viz., 0.005 A.U. The mercury lines show no shift but a slight broadening.

The experiments thus show that any electrical analogue of the Zeeman effect is, under the above conditions, largely masked by a widening of the lines.

The work was carried out at the Cavendish Laboratory, Cambridge, during the past winter; and the writer's thanks are due to Professor J. J. Thomson and to Professor Liveing for the facilities kindly accorded to him.